

## CS 430 Grammar Lab

### Part 1: Grammars and Ambiguity

Consider the following context-free grammar, written using the variant of BNF we've used in class.

$$\begin{aligned} A &\rightarrow V = E \\ E &\rightarrow E \wedge E \\ &\quad | E \sim E \\ &\quad | V \\ V &\rightarrow a | b | c \dots y | z \end{aligned}$$

1. List all non-terminals.
2. How many productions are there total?
3. List all terminals.
4. Write a leftmost derivation and draw the corresponding parse tree for the statement "x = a ~ b ^ c"
5. Is the grammar ambiguous? If it is, prove it by providing an example.

## Part 2: Associativity and Precedence

Consider the following grammar, written using the variant of BNF we've used in class.

$$\begin{aligned} A &\rightarrow V = E \\ E &\rightarrow E \wedge F \\ E &\rightarrow E \& F \\ &\quad | F \\ F &\rightarrow F \sim G \\ &\quad | G \\ G &\rightarrow ! G \\ &\quad | V \\ V &\rightarrow a | b | c \dots y | z \end{aligned}$$

6. Is the & operator left or right associative? Give an example sentence and parse tree.

7. List all operators in order of precedence from higher to lower. If two operators have the same precedence, list them on the same line.

8. Modify the grammar to allow chained assignments (e.g., "x = y = a ~ b ^ c"). List only the productions for any non-terminals that you add or modify. Is the = operator left or right associative?